L Number	Hits	Search Text	DB	Time stamp
1	204	345/107.ccls.	USPAT	2003/10/24 10:27
2	209	349/89.ccls.	USPAT	2003/10/24 10:27
3	332	359/296.ccls.	USPAT	2003/10/24 10:28
4	528	204/450, 600.ccls.	USPAT	2003/10/24 10:28
5	0	427/212.3.ccls.	USPAT	2003/10/24 10:37
6	1166	427/213.3.ccls. or 427/212.ccls.	USPAT	2003/10/24 10:37
7	2254	345/107.ccls. or 349/89.ccls. or 359/296.ccls. or (204/450, 600.ccls.) or 427/212.3.ccls. or (427/213.3.ccls. or 427/212.ccls.)	USPAT	2003/10/24 10:37
8	817	(345/107.ccls. or 349/89.ccls. or 359/296.ccls. or (204/450, 600.ccls.) or 427/212.3.ccls. or (427/213.3.ccls. or 427/212.ccls.)) and particle$1 WITH (coat$3 or polymer or copolymer or co-polymer)	USPAT	2003/10/24 10:39
9	0	(345/107.ccls. or 349/89.ccls. or 359/296.ccls. or (204/450, 600.ccls.) or 427/212.3.ccls. or (427/213.3.ccls. or 427/212.ccls.)) and glass NEAR2 transistion NEAR2 temperature	USPAT	2003/10/24 10:40
10	43	(345/107.ccls. or 349/89.ccls. or 359/296.ccls. or (204/450, 600.ccls.) or 427/212.3.ccls. or (427/213.3.ccls. or 427/212.ccls.)) and Tg	USPAT	2003/10/24 10:40

As a result, it was possible to obtain a good liquid crystal display element in which flicker in the display screen was greatly suppressed, and crosstalk was not noticeable to human eyes.

Example 3

The following will explain another example of the present invention. For ease of explanation, members having the same functions as those shown in the drawings pertaining to Example 1 above will be given the same reference symbols, and explanation thereof will be omitted here.

In the present Example, the liquid crystal layer **12** (shown in FIG. **6**) sandwiched between the insulating substrate **7** on the TFT **4** side and the insulating substrate **7** on the opposing side was a fluorine-based TN liquid crystal material having, within an operating range of 2V to 5.5V, a dielectric constant ϵ_P in the direction of the long axis of 7.3 (value with application of an effective voltage of 5.5V to the liquid crystal) and a dielectric constant ϵ_V in the direction of the short axis of 5.5 (value with application of an effective voltage of 2V to the liquid crystal). Further, cell thickness T_{sel} was 4.5 μm, pixel pitch was **264**Am, and resolution was XGA.

Other conditions were equivalent to those in Examples 1 and 2 above.

In the foregoing liquid crystal display element, TFT channel length L was not more than 6 μm, and the parameters of the liquid crystal layer **12** made of a TN liquid crystal material had effective dielectric constants ϵ_P in the direction of the long axis and ϵ_V in the direction of the short axis which, if $X=\epsilon_P+\epsilon_V$ and $Y=\epsilon_P \cdot \epsilon_V$, satisfy $Y=A \cdot X=B$ at a certain point in the ranges $9.5 \leqq X \leqq 15.5$, $5.43 \leqq A \leqq 5.75$, and $27 \leqq B \leqq 36.2$.

As a result, it was possible to obtain a good liquid crystal display element in which flicker in the display screen was greatly suppressed, and crosstalk was not noticeable to human eyes.

Example 4

The following will explain a further example of the present invention with reference to FIGS. **8** and **9**. For ease of explanation, members having the same functions as those shown in the drawings pertaining to Example 1 above will be given the same reference symbols, and explanation thereof will be omitted here.

As shown in FIGS. **8** and **9**, TFTs **4** are provided on an insulating substrate **7**. Scanning lines **1**, common lines **17**, and a gate electrode G have, for example, laminated structures of TaNx/α-Ta/TaNx, with the α-Ta having a film thickness of 340 nm.

A gate insulating layer **8** is made of, for example, a silicon nitride film 450 nm in thickness, and an intrinsic semiconductor layer **9** is made of, for example, an amorphous silicon layer. Further, a contact layer **10** is made of, for example, a microcrystalline silicon n^+ layer 40 nm in thickness. Further, a pixel electrode **3** is made of, for example, an ITO film 150 nm in thickness.

Signal lines **16** and drain and source electrodes D and S have, for example, laminated structures of α-Ta/TaNx and ITO films, with the α-Ta having a film thickness of 260 nm.

Further, on top of the foregoing members is provided a passivation layer **11** made of, for example, silicon nitride 300 nm in thickness. Here, the TFTs **4** have a channel length L of 4 μm and a channel width W of 10 μm.

Further, an insulating substrate **7** on the opposite side is provided with color filter layers **13** and black matrix layers **14**, and lower surfaces of these are provided with a counter electrode **6**, which is made of, for example, a transparent conductive film of ITO 200 nm in thickness.

Further, a liquid crystal layer **12** (shown in FIG. **9**) sandwiched between the insulating substrate **7** on the TFT **4** side and the insulating substrate **7** on the opposing side is made of a fluorine-based TN liquid crystal material having, within an operating range of 1.8V to 5V, a dielectric constant ϵ_P in the direction of the long axis of 7.9 (value with application of an effective voltage of 5V to the liquid crystal) and a dielectric constant ϵ_V in the direction of the short axis of 5.3 (value with application of an effective voltage of 1.8V to the liquid crystal). Further, cell thickness T_{sel} is 4.5 μm, pixel pitch is 264 μm, and resolution is XGA.

Here, it is sufficient if the various materials used (other than the liquid crystal) are equivalent from the point of view of the circuit. Further, the scanning lines **1**, the gate electrode G, and the common lines **17** may alternatively be made of a metal of high melting point, such as Cr or MoTa, or of a metal of low resistance, such as aluminum or aluminum alloy which are often used in integrated circuits (ICs). The gate insulating layer **8** of the TFT **4** may alternatively have a laminated structure of silicon oxide and silicon nitride films, or of an anodized film and a silicon nitride film. Further, the contact layer **10** may be made of an amorphous silicon n^+ layer instead of a microcrystalline silicon n^+ layer, and the drain and source electrodes D and S may alternatively be made of a barrier metal such as Ti or Mo.

In the foregoing liquid crystal display element, TFT channel length L was not more than 6 μm, and the parameters of the liquid crystal layer **12** made of a TN liquid crystal material had effective dielectric constants ϵ_P in the direction of the long axis and ϵ_V in the direction of the short axis which, if $X=\epsilon_P+\epsilon_V$ and $Y=\epsilon_P \cdot \epsilon_V$, satisfy $Y=A \cdot X-B$ at a certain point in the ranges $9.5 \leqq X \leqq 15.5$, $5.43 \leqq A \leqq 5.75$, and $27 \leqq B \leqq 36.2$.

As a result, it was possible to obtain a good liquid crystal display element in which flicker in the display screen was greatly suppressed, and crosstalk was not noticeable to human eyes.

The embodiments and concrete examples of implementation discussed in the foregoing detailed explanation serve solely to illustrate the technical details of the present invention, which should not be narrowly interpreted within the limits of such embodiments and concrete examples, but rather may be applied in many variations, provided such variations do not depart from the spirit of the present invention or exceed the scope of the patent claims set forth below.

What is claimed is:

1. A liquid crystal display device which includes a liquid crystal material having an effective dielectric constant ϵ_P in a direction of a long axis and an effective dielectric constant ϵ_V in a direction of a short axis which, if $X=\epsilon_P+\epsilon_V$ and $Y=\epsilon_P \cdot \epsilon_V$, satisfy $Y=A \cdot X-B$ at a certain point in the ranges $9.5 \leqq X \leqq 15.5$, $5.43 \leqq A \leqq 5.75$, and $27 \leqq B \leqq 36.2$.

2. A liquid crystal display device which includes a liquid crystal material having an effective dielectric constant ϵ_P in a direction of a long axis and an effective dielectric constant ϵ_V in a direction of a short axis which, if $X=\epsilon_P+\epsilon_V$ and $Y=\epsilon_P \cdot \epsilon_V$, satisfy $Y=A \cdot X-B$ at a certain point in the ranges $10.2 \leqq X \leqq 14.7$, $5.43 \leqq A \leqq 5.75$, and $27 \leqq B \leqq 36.2$.

3. A liquid crystal display device which includes a liquid crystal material having an effective dielectric constant ϵ_P in a direction of a long axis and an effective dielectric constant ϵ_V in a direction of a short axis which, if $X=\epsilon_P+\epsilon_V$ and